SCIENCE

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THE NEXT STEP IN IMPROVEMENT IN WHEAT CROPPING—HOW TO INCREASE WHEAT PRODUCTION IN 1918 AND 1919[1]

YOUR secretary has requested me to prepare a paper on soil organisms affecting cereal production. The subjects which should come before you at this time are without question of the greatest importance to this nation and particularly to the cereal-producing states, and, of these, none are of greater import than those which touch upon the causes of seed and crop deterioration in cereals, under the general cropping and marketing processes now in use. In the case of wheat on the general market it may be truthfully described as yearly more closely approaching the "no grade" condition because of mixtures of kinds and qualities through the jumbling methods of the handling processes. In the case of the seed used on the land in such general cropped regions, the start or first crops produced are always at "No. 1 quality." The finish is always reached after a gradual yearly reduction in purity, vitality and weight quality, until crop failure ushers in seed importation, and then, final failure of the cereals as the chief crops. Are these consequences a matter of necessity?

I am well aware that agriculturists, fertilizer experts, agronomists, and perhaps some plant pathologists, do not agree with me in assigning as great importance to the rôle of plant diseases and to soil and seed sanitation in cereal cropping as I do. However, stock raising, gardening and

[1] Read before the third Interstate Cereal Conference.

fruit growing communities have in a large way already adjusted themselves to sanitary methods of agriculture. At the risk of appearing too pointed, I bring to you the thought that it is time that cereal agriculture be adjusted so that the cropping methods known under the heading of tillage, crop rotation and soil fertilization may come into their own and prove their real merits through the agriculturists, agronomists and the cerealists getting together on a program which shall properly take into account the teachings of the soil biologists, plant physiologists and pathologists for the great cereal crops as has been done for flower and vegetable farming, for potatoes, fruit cropping and other types of intensive crop culture. It is notorious that aside from the applications of the principles of seed disinfection for the prevention of smut and a considerable work looking toward the selection of disease-resistant varieties very little in an organized way has been done looking toward putting cereal agriculture on a plane of sanitary cropping comparable to the intensive methods used with the crops mentioned.

I think you will agree that the present wheat bushelage can not on the average year be greatly increased by just sowing more acres on the same old areas in the same old way or even in the same districts unless a great change is introduced. How wonderful has been the influence of plant pathology on the grape industry, on the fruit industry, on the apple crop and for the potato crop. When we want to grow these in the best way do we forget all principles of soil sanitation or of disease introduction and modes of distribution and infection? If the principles of sanitation associated with proper cropping methods in these more confined crops have been of benefit, what may they not do for the cereal crops when properly applied and adjusted to the cropping conditions of each great cereal district.

Now that the governmental officials have appealed to this country to raise the greatest possible wheat crop, what have we done to get it? We have only advocated the sowing of the greatest number of acres in the quickest possible time. Granted that we were unprepared to do otherwise, shall the process be continued? Every conceivable bushel of every conceivable kind of wheat, mixed, diseased or otherwise, has gone into the soil and into any area available. Nothing more can be done now than to see that the crop is properly harvested so as to save the greatest possible bushelage in the best possible condition to prevent its food value from being injured, and particularly, that it may not be spoiled as seed for the crop of 1918–19. If such better harvesting is to occur, it must take place in a sanitary method. If it is to be done intelligently, there must be a comprehensive plan; and those who handle the crop after it is grown should know that their handling processes are as important as the cropping processes.

Experiments in North Dakota with potatoes, flax, wheat and allied cereals, extending over the period of time from 1890 to 1917, dealing always with the problems of seed disinfection, soil purification and cropping methods for the control of disease, allow me to say with assurance that soil and seed infection has largely accounted for the many anomalous results obtained in various extensive experiments on wheat and cereal cropping, particularly as referring to variety tests, the influence of rotation, methods of plowing, tillage, etc.; for it is now known that through all these experiments in all cereal states there has been acting in greater or less virulence the constant attack of seed- and soil-borne diseases, which have not been properly taken into account. This lack of the proper consideration of sanitary measures as affecting

cropping processes accounts chiefly for the reduction of yields and the deteriorated quality of the grain which comes from year to year from the old, rather constantly and extensively cropped cereal areas. I call your attention to the history of wheat cropping in California and in the semi-dry regions of Washington and Oregon as affected by smut epidemics. Ordinarily, in the wetter regions, seed disinfection for the prevention of stinking smut of wheat is all that is necessary. It is not even necessary to have a reasonable crop rotation, but in semi-dry regions the smut spores do not so readily die out by rapid germination; and the combination harvesting and threshing has proved to be a process which quickly undoes the work of possible control of smut through seed disinfection. That process of cutting and threshing the grain and returning the chaff, straw and dust to the soil, evenly distributed, did more than introduce smut. With it goes the spores of a large number of so-called "imperfect fungi," particularly the Helminthosporia and Fusarial types. These and others have brought about seed and root blighting, and with the smut, drought and other conditions soon throws the crop below a paying condition.

In the hard spring wheat regions of Minnesota, North Dakota, South Dakota and Montana, one readily sees the detrimental influences of extensive cereal culture as affecting the introduction, even distribution and destruction by the "imperfect fungi" as transmitted by the seed to new areas, by farming implements, wind and wash waters, and as imbedded in the soil in the dead bodies of the previous crop.

It is a peculiarity of all these seed and soil borne fungi that they are destructive regardless of the year and soil conditions, and vary in intensity according to weather and soil conditions. Thus in intensely dry seasons, particularly preceding the harvest time, old wheat lands often produce almost normal, plump seeds, but when there is sufficient water content in the soil and sufficient rainfall during the heading period to make a normal stand and growth for what should be a large yield, these parasites resident in the seed and in the old stubble lands and often evenly distributed during moist weather from plant to plant, bring about a rag-like condition of the cellular tissues of the straw. They invade it at all parts, and bring about an intense blighting of the flowers and ovules at the time of seed formation so that the heads are never properly filled. Under these conditions seldom any of the grains reach normal form as to color, size and weight.

To call your attention to what I have in mind I can do no better than to quote from some previous publications of mine in this line. From Bulletin 13, North Dakota Experiment Station, 1894, p. 26:

> It is apparent that after all is said concerning culture of wheat in the northwest, haphazard, careless methods of saving the grains at harvest time are yet to be placed as the chief cause in the reduction of the milling quality of the wheat as it now appears upon the market.

From "Plans for Procuring Disease Resistant Crops" in Report of The Society for the Promotion of Agricultural Science, 1907:

> At present the farmers are confused by conflict of authority as to the proper line of seed improvement. For the most part, they believe that seed for crops must be bred to a high standard upon a high-class soil and that it will degenerate when put into general cropping conditions on their farms. . . . The facts remain that crops suffer under systems of constant cropping, while the idea of home grown seed for local crops is fast gaining recognition as right in principle. . . . It is recognized that crop diseases, as well as chemistry of soil and air, play a great, if not master, rôle. . . . Crop yields more often depend upon features of disease resistance, or upon conditions of environment in which disease producing organisms can not be active, than upon whether the soil is especially balanced chemically. Crops fail as often through

rust, blight, wilt and rot, and insect mites on fertile soils as upon unfertile soils.

From "Interpretations of Results noted in Experiments upon Cereal Cropping Methods after Soil Sterilization," in *Proceedings of American Society of Agronomy*, Vol. 2, 1910:

Soils and seed may be, and usually are, infected by several destructive wheat-destroying, parasitic fungi. Indeed, these are found to be apparently cosmopolitan in distribution with the wheat plant. They are especially transmitted in the seed internally, and it seems quite certain that they are sufficient in their influence to account for most of the causes of rapid first crop deterioration and for the difficulties which farmers have in introducing any sort of culture, which will again raise the standard of crops. Their exclusion, in so far as it is perfectly or imperfectly done, is sufficient to account for the anomalies in soil sterilization experiments.

From "Conservation of the Purity of Soils in Cereal Cropping," October, 1910, before Dry Land Congress, Spokane, in Science, N. S., Vol. XXXII., No. 825:

I recommend both our trained agriculturists and the farmer to look for help from a careful consideration of soil sanitation. . . . I consider it particularly important that this question should be brought before this congress, for this meeting is located at a point west of the center of the last great virgin soil areas of this country. And because, while I recognize the great good that is done by the advocates of the conservation of the chemical qualities of the soil and still remain a strong advocate of the importance of that feature, I feel that we have followed it so persistently as to lose sight of other features which have vitiated many of the conclusions which have been drawn. . . . *My belief is that we must yet be able to produce the bread of the world by the use of extensive machinery and upon extensive plans, such as are yet being carried on in the new lands of the west. I have set forth the reasons why this can not be done unless we recognize this question of soil sanitation, or, if you will, the necessity of conserving the virgin purity of the land.* I am, however, confident that with the proper understanding of the methods which are now known for selecting seed, disinfecting seed, rotating crops and perfecting the seed bed there should be no necessity of growing wheat upon the costly lands now under intensified farming systems, and that there is no immediate necessity of abandoning the cropping to cereals on the large plan which is characteristic of the northwest. I believe firmly, however, if we do not thus recognize this matter of the necessity of soil sanitation and soil disinfection by means of proper cultivation, and well-planned series of crop rotation, that, no matter how fertile the soil of one of your western valleys may be, no distant year will see your crop fall very close to the world average for that particular cereal.

From "Cereal Cropping: Sanitation, A New Basis for Crop Rotation, Manuring, Tillage and Seed Selection," in Science, N. S., Vol. XXXVIII., No. 973, 1913:

Deteriorated wheat, as seen in depressed yields and low quality, as now quite commonly produced in the great natural wheat-producing regions of this country, is not, primarily, a matter of lost fertility or of modified chemical content of the soil, but is specifically a problem of soil and crop management. Crop rotation, for example, is not, primarily a farm process which is likely to conserve the fertility of the soil, but when properly arranged in a system so that the proper crops follow one another, it is definitely a sanitary measure tending to maximum production. . . . Wheat does not do well in the presence of its own dead bodies, not because of any changes which the wheat plants have made in the content of the soil fertility, nor because of any peculiar poisons (toxins) which the crops may be thought to have introduced, but primarily, because of infectious diseases which are characteristic of the crop. . . . Proper methods of soil tillage and handling of manures and artificial fertilizers are not merely measures for supplying plant food, but also involve vital features of a sanitary nature. . . . That there is a real problem before the agriculturists of the world, especially as affecting the question of maintaining the output of wheat in amount and quality, all must agree. The present approximate annual output of 700,000,000 bushels in its occurrence is somewhat analogous to the varying annual output of gold. It is maintained at these approximate figures, essentially not through increased yields of grain of better quality per acre on old cultivated areas through certain exact methods, but rather through the breaking up or turning over of new areas, in the same wasteful methods. The most alarming feature of the whole condition rests not so much in these facts as in the evident rapid deterioration of the quality of grain which invariably accom-

panies the first few years of cropping upon new land areas.

All these statements have to do with the fact that wheat in particular and most cereal grains are attacked by certain parasitic fungi which have been usually considered saprophytes or semi-parasites. They attack in such manner as to invade all parts of the plant body, break down the tissues, clog up the ducts, and rot off the roots, and they are particularly destructive as the seedling and stooling stages, and finally cause blighting and shrivelling of seed. We have developed a particularly interesting method of attempting to purify such internally infected wheat grains and other cereals by special methods of heavy seed disinfection, aiming at seed-coat disinfection. The seedlings are then grown upon agar just as one grows a pure culture of a fungus or a bacterium. This allows proper study of the root characters and other conditions as affected by the organisms, and makes it possible to separate uninfected seedlings to be grown on purified soil. This work has been associated with special studies upon soil and seedling purification in many ways. The results of tests extending over a number of years show that continuous cropping to wheat and flax brings about a continuous cumulative infection of soil and seed. In flax the wilt fungus, *Fusarium lini,* remains indefinitely in fertile soil and makes it essentially sterile for that crop. So, also, certain fungi of wheat eat away at the roots and attack seedling plants from the stubble or seed and through accumulation in the seed carry always an accumulating infection to new or cleaned lands, undoing the proper effects of tillage and crop rotation.

A few of the genera particularly concerned in the destructive work upon wheats are *Alternaria, Colletotrichum, Helminthosporium* and *Fusarium.* Each of these is peculiarly destructive in its own way, and in certain years one or other may excel in the destruction of the crop.

To these attacks the wheat plant reacts as best it can by the growing and sending down of new roots, adventitious or brace roots, as fast as the old ones die. Its fibrous rooting capacity stands it well in hand, with the result that, unlike flax, it usually holds on to the ground and does not give an absolute failure, though a very irregular crop is characteristic. The disease generally known as scab falls under the group known as *Fusarial* infections. These no doubt spread from head to head to a certain extent, but by far the largest amount of damage is done by direct attack upon the roots just as in flax-wilt and other Fusarial wilts. I need not go further into this phase of the subject.

If the diagnosis is correct, we shall never get the full benefits from the campaign for a better agriculture until steps are taken to rather suddenly and generally bring about an actual compliance in better sanitary methods of harvesting the crop and handling the soil and seed.

Mr. Rockwell Sayre, of Chicago, has not been wholly wrong in his campaign for compulsory crop rotation laws. Our people do not like to be compelled to do anything. Perhaps the better method is to educate, but general education comes too slowly to be effective in any sanitary measure. On small areas such as are occupied in potato cropping and in intensive farming propositions the educational process can be brought about and rather effectively carried into operation, but with the great cereal crops where practically three fifths or more of the entire area of a state is put under wheat and allied cereal culture, these diseases, under present methods, run riot.

What to do: It is with a good deal of temerity that I offer the following suggestions. I recommend through this congress

to the United States Department of Agriculture that it, in association with proper state authorities, immediately put on an extended wheat crop survey, (1) to insure a proper harvesting and selecting of the fields from which seed is to be saved for the crop of 1918, so that selection may be made on the basis of freedom from disease and purity as to variety; and (2) to save the seed so it shall be as free as possible from water effects following the period of maturity; for it is through moisture that the invasion of the seed coats becomes most active. This invasion prevents ordinary seed disinfection from being effective.

With this seed survey a soil survey should go hand in hand as follows: (1) Map and locate the virgin lands of the wheat states; (2) map those lands which have had crops on them for the last five to seven years which are of such nature as not to bear the chief diseases of the wheat crop, and (3) set aside these virgin or clean lands and prepare them for the wheat crop of 1918 and 1919.

As a corollary to the seed and soil surveys, the United States Department of Agriculture should commandeer and contract for sufficient of the wheat coming from the virgin lands or from the field crop inspected areas of the older regions which are found to be free from disease, to redistribute to the lands which by the survey have been found to be essentially free from the chief diseases of wheat. Finally, there should be put on a campaign of education which shall reach every grower of wheat in the United States.

If this national survey of soil and of seed production is to be done so as to be effective on the crop of 1918, the work should start before the harvest of 1917, and be so continuously followed up that the plowing may be done for next year and the ground prepared for early seeding. Somewhat over one half of all the land of North Dakota has still been untouched by the plow, or at least has not been subject to wheat culture. A similar condition exists in most of the spring wheat-producing states. A proper seed bed for the production of wheat can be made upon this new land if it is broken early in the present summer; and, if it is plowed during any portion of this summer, it can be packed and worked down in fine shape for some crop which is suitable to precede wheat, so that in 1919 the wheat can go into this land without further plowing in the finest possible condition.

To summarize: How shall we improve the bushelage and quality of wheat produced in 1918 and 1919? (1) Put on a field crop survey which will locate seed of highest weight and color quality free from disease infection and weather effects; (2) locate the soils upon which such seed should be seeded; (3) take the proper steps to procure that seed and see that it is sowed. Should the government find it necessary to force a proper consideration of the lands upon which wheat is to be sowed and the use of the proper quality of seed, properly disinfected, it would, in my belief, eventually receive the entire sanction of the American farming and business public and we would learn within two or three years the enormous value which would accrue from proper soil and seed sanitation in the cropping cereals.

H. L. Bolley
North Dakota Agricultural College,
May 30, 1917

SCIENTIFIC EVENTS

AGRICULTURAL EDUCATION AND RESEARCH IN CHINA[1]

Considerable attention is now being devoted in China to agricultural education and experimentation in various classes of institutions. An experiment station was located at Peking in 1907 under the control of the board of agriculture, industry and commerce. An experimental tract of nearly 300 acres is avail-

[1] From the *Experiment Station Record.*

able, and departments of crops, soils, animal husbandry, horticulture, floriculture, entomology, botany, forestry, bacteriology and biology have been put in operation. In 1908 an agricultural college was organized in connection with the station, but this was disbanded in 1915.

Subsequently an agricultural college and experiment station was established at the capital of each province along much the same lines as at Peking, and many other stations in addition. There are now reported to be 130 stations in the 22 provinces, of which 31 are in Chihli, 25 in Szechwan, 15 in Hu-Long-Kiang, 7 in Hupeh, and 7 in Kwangtung.

Among these are two cotton experiment stations, one at Cheng Ting Hsien, Chihli, and one at Nan T'ung Chou, Kiangsu, with a third under consideration at Tung Haing Chou, Hupeh. Experiments are being conducted at these stations in seed selection, seed distribution, plant harvesting, soils and manures, treatment of pests and cotton weaving. A corps of students is also being trained at these stations. H. H. Jobson is in charge of the organization of the cotton work, with H. K. Fung as associate.

Stock-raising experiment stations have been established at Kalgan and Shih Men Shan, Anhui. These are expected to study the improvement of breeds of domestic animals, promote the breeding and sale of stock and stock raising enterprises, and the cultivation of forage crops.

Considerable attention is also being devoted to forestry in China. A department of forestry was organized in January, 1916, with a forestry commissioner in each province. Forestry experiment stations and training schools have been established at Ch'ang Ch'in Hsien, Shantung, and in the Temple of Heaven at Peking.

The university at Nanking has maintained a college of agriculture and a school of forestry for several years. This is an American-supported institution, and in 1915 had enrolled about 70 students in agriculture. A colonization association has been organized under its auspices, with provision for the reservation of about 35 acres in each colony for a model farm. A tract already purchased on Purple Mountain, just outside Nanking, is to be used as an experiment station in connection with the different colonies.

An agricultural experiment station was opened at Nanhsuchou, Anhwei, in 1915, as a part of the American Presbyterian mission station. Agricultural work was taken up at this institution partly as a practical way to teach Christianity, partly to make friends and partly to improve economic conditions. The station is located on the railway between Nanking and Tientsin, and attempts to serve an area of about 6,000 square miles and from 1,500,000 to 2,000,000 people. The farming methods in use are those of from one to two thousand years ago. Special prominence is being given in the experimental work to seed selection, better tillage methods, more and better fertilization, drainage and animal husbandry. The work is to be largely of a demonstration nature during the present pioneer stage, and will also include an agricultural school, a school farm and short winter courses for farmers. J. Lossing Buck has been in charge of the agricultural work at the station from the outset.

THE BRITISH METEOROLOGICAL COMMITTEE

THE eleventh annual report of the British Meteorological Committee for the year ended March 31, 1916, states, according to an abstract in the London *Times*, that during the year the staff of all departments of the office was fully occupied in supplying information in reply to inquiries from the various departments of the Admiralty and the War Office. "The results of meteorological inquiries initiated in what appeared to be the remote interest of the theory of the circulation of the atmosphere have turned out to have important practical bearings, and collections of statistics compiled in the ordinary course of meteorological duty have now come in most usefully to meet urgent requirements." "A separate unit of the Royal Engineers has," says the report, "been created for meteorological service in the field. The service with the Expeditionary Force in France is under the command of

Major Gold, one of the superintendents of division in the office, and that with the force in the Eastern Mediterranean under Captain E. M. Wedderburn, honorable secretary of the Scottish Meteorological Society. With him is Lieutenant E. Kidson, a graduate of Canterbury College, New Zealand, who has distinguished himself as magnetician in the service of the Carnegie Institution of Washington, and came to this country to offer his services. In the organization of these meteorological services, the committee has received great assistance from one of its members, Major H. G. Lyons, R.E., formerly director-general of the Egyptian Survey Department, whose services were lent by the War Office in view of the importance of an adequate knowledge of the weather to the proper conduct of naval and military operations in the Mediterranean, to which attention was called by the Admiralty. Major Lyons has taken charge of that department of the work of the Office from May 17, 1915, and more recently he has been appointed to represent the War Office on the committee. The special thanks of the Admiralty for the services of the meteorological officer in the Mediterranean have been received through the War Office. In view of the importance of coordinating the experience of flying officers with the work of the office and observatories in order to obtain more effective knowledge of the structure of the atmosphere for the use of the air services, the committee represented to the director of military aeronautics the desirability of appointing a professor of meteorology to the Royal Flying Corps (with the rank of major during the war). The director of military aeronautics concurred, and the Army Council approved the appointment of Lieutenant G. I. Taylor, R.F.C., to that office. Major Taylor was Schuster reader in meteorology from February 20, 1912. His services were lent to the Board of Trade for meteorological work on the steamship *Scotia*, chartered for the investigation of ice in 1913.

THE WISCONSIN PHARMACEUTICAL EXPERIMENT STATION

At the request of the State Pharmaceutical Association, the Wisconsin Pharmaceutical Experiment Station was established by special legislative enactment four years ago. Its meager budget of $2,500 nevertheless yielded modest results since practically the entire sum was expended in productive work. This was made possible because of the close cooperation of the station with the department of pharmacy of the university.

As a war measure, the present legislature has doubled the income of the station. The pharmaceutical garden has been increased from three to ten acres, with ground that admits of an increase to thirty acres as soon as the means of the station permit. This increase in garden area was made largely at the request of the Office of Drug-Plant and Poisonous-Plant Investigations, which keeps an expert on the grounds, in order that acre experiments of greater economic significance might be carried out.

The station also enjoys a research fellowship of $500 for the investigation of thymol and related problems, established for the academic year 1917–18 by Fritzsche Bros., of New York. Another $500 previously offered as fellowship by the Kremers-Urban Co., pharmaceutical manufacturers of Milwaukee, was utilized toward an endowment fund for pharmaceutical research, a movement, which, like the station movement five years ago, was started by the pharmaceutical alumni of the university.

In addition, the income from $10,328, bequeathed by the wills of the late Mr. and Mrs. Albert Hollister, is available for graduate study and research in the form of the Hollister fellowship in pharmacy.

SCIENTIFIC NOTES AND NEWS

President R. A. Pearson, of the Iowa State College, is acting as assistant to the secretary of agriculture to cooperate with the state boards for food production and conservation.

Dr. Frank M. Chapman, curator of ornithology in the American Museum of Natural History, is now in Washington, where he is director of the Red Cross Bureau of Publications. He is the editor of the newly established *Red Cross Bulletin*, which is designed

to keep the public informed as to the activities of the organization.

DR. C.-E. A. WINSLOW, of the Yale School of Medicine, is engaged in Red Cross work in Russia. During his absence the editorship of the *Journal of Bacteriology* has been assumed by Professor Leo F. Rettger, Yale University. Manuscripts for the journal should be sent, as heretofore, to Professor Winslow's office, Yale School of Medicine.

DR. AUGUSTUS TROWBRIDGE, professor of physics in Princeton University, has been made director and commissioned a major in the signal corps of the U. S. Army. Under him there is now a staff of twenty-five men working in the Palmer Physical Laboratory.

LEAVE of absence during 1917–18 for war service has been granted to Professor J. S. Shearer of the department of physics of Cornell University. He is directing the standardization of X-ray apparatus for the medical corps.

DR. JOHN A. ELLIOTT, associate plant pathologist of the Delaware College Experiment Station, has been elected plant pathologist of the Arkansas Agricultural Experiment Station, to fill the vacancy created by the resignaiton of Professor J. Lee Hewitt, who has become secretary and chief inspector of the Arkansas State Plant Board.

M. EMILE PICARD, recently elected permanent secretary of the Paris Academy of Sciences, has been appointed to represent the French government on the International Geodetic Association.

M. ERNEST SOLVAY, the distinguished Belgian industrial chemist, who has made large gifts for the endowment of chemical and physical research, has been elected a corresponding member of the Paris Academy of Sciences in the place of the late Sir Henry Roscoe.

GENERAL BOURGEOIS, professor of astronomy in the Paris School of Technology and director of the geographic service of the French Army, has been elected a member of the Paris Academy of Sciences in the Section of Geography and Navigation, to fill the place vacant by the death of M. Phillip Hatt.

THE University of Nebraska has conferred the doctorate of science on Patrick Joseph O'Gara, '02, chief in charge of agricultural and smelter waste investigations for the American Smelting and Refining Company at Salt Lake City. For the past four years Dr. O'Gara has been making extensive investigations on the effects of gaseous and solid smelter wastes on vegetable and animal life.

MR. C. D. GEIDEL, chemist and bacteriologist in the state food laboratory, Madison, Wis., has accepted a position in the Bureau of Chemistry, Washington, D. C., and assumed his new duties on June 15.

H. K. BENSON, instructor in industrial chemistry at the University of Washington, Seattle, and director of the Bureau of Industrial Research, will spend his summer vacation at the plant of the American Nitrogen Products Company at La Grande, Wash., where he will conduct research work relating to the manufacture of nitrogen products from the air by use of electricity. Professor Benson will return to his school work in the fall.

PROFESSOR C. E. DAVIS has resigned as professor of chemistry at the Utah Agricultural College at Logan, and accepted a position as research chemist for the National Biscuit Co., with headquarters in the Havemeyer Laboratory, Columbia University.

MR. L. W. BAHNEY has left the Sheffield Scientific School of Yale University to take a position as metallurgical engineer with the Scovill Manufacturing Co., Waterbury, Conn.

PROFESSOR LLOYD VAN DOREN, of Earlham College, Richmond, Ind., has been cooperating with The McIntosh Stereopticon Co., Chicago, in the compilation of a series of lantern slides suitable for illustrating topics in general chemistry and in industrial chemistry.

MR. BURR A. ROBINSON has resigned as assistant secretary of the American Institute of Mining Engineers to go into industrial work, and Professor G. A. Roush, of Lehigh University, has taken up his work as managing editor of the institute's monthly bulletin.

The following assistants in the American Museum of Natural History have enlisted in the army: Carlos D. Empie and Harold E. Anthony, mammalogy; Charles Camp, vertebrate paleontology; Leo E. Miller and James P. Chapin, ornithology. Howarth S. Boyle, ornithology, is now in the service of the navy.

Dr. Hermann M. Biggs, state commissioner of health of New York, is chairman of a subcommittee on tuberculosis appointed by the general medical board of the Council of National Defense. Other members of this special committee are: Dr. John W. Trask, of the United States Public Health Service; Dr. George T. Palmer, of Springfield, Ill.; Dr. Charles B. Grandy, of Newport News, Va.; Dr. E. R. Baldwin and Dr. Lawrason Brown, of Saranac, N. Y., and Mr. Homer Folks, of New York.

The commission for the prevention of tuberculosis, which the Rockefeller Foundation is to send to France, will, as has already been announced in Science, be headed by Dr. Livingston Farrand, president of the University of Colorado, who for ten years was the executive secretary of the National Association for the Study and Prevention of Tuberculosis. Dr. Farrand will be accompanied by Dr. James Alexander Miller, of New York; Homer Folks, of New York, and Professor Selskar M. Gunn, of Boston. Hermann G. Place, of New York, has been appointed secretary. Dr. Miller is professor of clinical medicine in Columbia University, the director of the tuberculosis work of Bellevue Hospital, and president of the Association of Tuberculosis Clinics in New York City. Holmer Folks is the secretary of the State Charities Aid Association. In addition to his connection with the commission, Mr. Folks will take charge of the tuberculosis relief work of the American Red Cross in France. Selskar M. Gunn holds a professorship in the Massachusetts Institute of Technology, is the secretary of the American Public Health Association, and editor of the *American Journal of Public Health.*

The war council of the American Red Cross announces the appointment of a medical advisory committee, the membership of which is as follows: Dr. Simon Flexner, director of the Rockefeller Institute, chairman; Dr. John W. Kerr, assistant Surgeon General, United States Public Health Service; Dr. Hermann M. Biggs, director of the New York State Department of Health; Dr. William H. Welch, dean of the School of Hygiene, Johns Hopkins University; Dr. Frank S. Billings, professor of medicine, University of Chicago; Dr. M. J. Rosenau, professor of preventive medicine, Harvard University; Mr. Wickliffe Rose, director of the International Health Board; Dr. Victor C. Vaughan, professor of hygiene, University of Michigan; Dr. Charles V. Chapin, Department of Health, Providence, R. I.; Dr. Richard P. Strong, professor of tropical medicine, Harvard University; Dr. Richard M. Pearce, professor of research medicine, University of Pennsylvania. Ex-officio members of the committee will be: Colonel Jefferson R. Kean, director general, department of military relief, and Dr. T. W. Richards, assistant director general, department of military relief. Permanent offices for the medical advisory committee will be opened in the Red Cross headquarters in Washington, in charge of Dr. Richard M. Pearce, who will act as secretary.

"Science and industry: the place of Cambridge in any scheme for their combination" was the subject of the Rede Lecture delivered at Cambridge by Sir R. T. Glazebrook, F.R.S., fellow of Trinity, and director of the National Physical Laboratory.

Charles Horton Peck, former state botanist of New York, died at his home in Albany on July 11. Dr. Peck's official term of scientific service began in 1867, and extended over a period of forty-six years. He retired on account of illness and age in 1913, and at the time of his death was in his eighty-fifth year.

Alois von Isakovitz, an industrial chemist, known for his work on perfumes and flavoring materials, born in Bohemia in 1870, died at his home in Montecello, New York, on June 5.

Edward Randolph Taylor, since 1877 a manufacturer of chemicals at Penn Yan, N.

Y., known for his work on the electric furnace and the determination of carbon in steel, and later for work on the conservation of water for power, has died at the age of seventy-three years.

PHILIPPE DE VILMORIN, known for his work in plant and animal genetics and head of the well-known seed-growing establishment, died on June 30, at the age of forty-five years.

DR. VITALI, formerly professor of pharmaceutical chemistry in the University of Bologna, has died at Venice at the age of eighty-five.

WE learn from *Nature* that the late Lord Justice Stirling's herbarium, consisting chiefly of about 6,000 varieties of mosses and liverworts from many parts of the world, has been presented by Lady Stirling to the Tunbridge Wells Natural History Society.

FREE public lectures will be delivered in the lecture hall of the museum building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock during the summer as follows:

July 7. Wild flowers of summer, by Dr. N. L. Britton.

July 14. Plants grown by the American Indians, by Dr. A. B. Stout.

(Exhibition of Flowers, July 14 and 15.)

July 21. Flowers for the summer garden, by Mr. G. V. Nash.

July 28. How the introduction of foreign plant diseases is prevented, by Mr. H. B. Shaw.

August 4. Floral and scenic features of Cuba, by Dr. M. A. Howe.

August 11. Books on gardening, by Dr. J. H. Barnhart.

August 18. Trees and flowers of the Yellowstone National Park, by Dr. P. A. Rydberg.

August 25. Insect enemies of plants, by Dr. F. J. Seaver.

(Exhibition of Gladioli, August 23–26.)

THE department of physics at the University of Illinois is giving the following popular lectures in the summer session on recent advances in physics:

Professor C. T. Knipp: The production of high vacua; discharge of electricity through gases; electrons and X-rays; the electrostatic and magnetic deflection of cathode rays (electrons); positive electricity.

Professor Jakob Kunz: The electron; Radiation; Photo-electricity.

Mr. Sebastian Karrer: X-rays and structure of crystals.

Mr. C. S. Fazel: Atomic models and chemical properties; Atomic models and radiation.

Mr. H. T. Booth: Temperature measurements.

Mr. W. H. Hyslop: Wireless telegraphy.

Professor J. W. Hornbeck (Carleton College): Electromagnetic waves.

Professor F. R. Watson: Acoustics of buildings; Acoustical phenomena.

THE Bureau of Fisheries announces the continuation of the investigation of lakes in Wisconsin, which is directed by Dr. E. A. Birge, of the University of Wisconsin. Dr. N. L. Gardner, of the University of California, is making a systematic and economic study of the marine algæ of the Pacific coast. A small allotment has been made for investigation of parasites of fishes in Oneida Lake, N. Y., in connection with the biological survey of that lake under the direction of Dr. C. C. Adams, of the New York State School of Forestry. Dr. J. J. Wolfe, of Trinity College, N. C., assisted by Mr. Bert Cunningham, will continue his studies of the plankton collections in Chesapeake Bay made by Lewis Radcliffe in connection with the extended survey of the bay. Mr. Willis H. Rich, of Stanford University, will continue the investigations of the habits and migrations of the Pacific salmons. Dr. J. E. Reighard, of the University of Michigan, will be engaged in studies of the breeding habits of fishes and will also direct investigation of the distribution and habits of salmonoid fishes of the Great Lakes, based in part upon field observation and collections and in part upon a study of scale characters. Among other investigations that will be continued in progress are those of Dr. A. H. Wright, of Cornell University, on the natural history and propagation of frogs, and Professor Trevor Kincaid, of the University of Washington, on the culture of oysters in Puget Sound.

UNIVERSITY AND EDUCATIONAL NEWS

At The Ohio State University, J. A. Bownocker, professor of inorganic geology and curator of the museum since 1901 and state geologist since 1906, has been made head of the department of geology to succeed the late Charles S. Prosser. J. E. Carman, Ph.D. (Chicago), assistant professor, has been made professor of historical geology and curator of the museum, and Arthur Bevan, A.B. (Ohio Wesleyan), for the past two years a graduate student at Chicago, has been made instructor in geology.

Harold Veach Bozell, director of the school of electrical engineering of the University of Oklahoma, who during the past year has been on sabbatical leave studying in Yale University, has been appointed to a chair in the Sheffield Scientific School. Associate Professor Lester William Wallace Morrow, of the University of Oklahoma, has been promoted to succeed Professor Bozell, and T. G. Tappan, now of Cornell University, has been appointed to the position of associate professor of electrical engineering in the University of Oklahoma.

At Oberlin College, Robert E. McEwen, Ph.D. (Columbia, '17), was recently appointed instructor in the department of zoology.

L. D. Batchelor has been appointed professor of plant breeding in the University of California, his work being at the citrus station of the graduate school of tropical agriculture.

Dr. Ernest M. R. Mankey, of the University of Illinois, has been appointed head of a new division of plant physiology at the Delaware College.

DISCUSSION AND CORRESPONDENCE

THE USE OF PREHISTORIC CANADIAN ART FOR COMMERCIAL DESIGN

The Archeological office of the Geological Survey, Department of Mines, Ottawa, is now prepared to show to Canadian manufacturers and their commercial artists a very complete series of several hundred examples of motives for decorative and symbolic designs and trade marks, although it has no facilities for making designs. These motives are all from prehistoric Canadian art and handiwork. Such archeological material supplies not only the oldest human decorative material from Canada, but material unsurpassed in distinctiveness. The fossils, animals, flowers, leaves, fruits, etc., and especially the historic objects from Indians found only in Canada would no doubt supply other motives capable of use as the lotus blossom has supplied innumerable designs used throughout much of the world.

Mr. Joseph Keele, of the ceramic laboratory of the department, has used some of these shapes and motives in the modelling of part of the vases made to test Canadian clays. Many of these pottery products after serving their purpose were given to the Women's Canadian Club, who sold them for the benefit of the Red Cross. At the sale there was a greater call for the vases made after these Canadian motives than for any of the others. Eighteen manufacturers, representing six totally different industries, a museum and an art school have already applied for copies of these motives. This is over 20 per cent. of those informed of the opportunity and one firm has already sent two representatives from Toronto to Ottawa to look into the matter. They express themselves as surprised at the quantity and usefulness of the material and have already selected motives for their designers to use.

This seems to prove that there is a demand for motives or inspiration for new and characteristic Canadian designs and trade marks. This demand we may expect to grow at the close of the war, when Canada makes special efforts to stand on an even footing with other countries in producing manufactures recognized all over the world as individually and characteristically her own.

These motives may be used as they are or may be conventionalized or dissected or multiplied or developed in several of these ways. Designers may use them as inspiration for designs which may be applied to fronts of buildings, gargoyles, fountains, terra cotta, pottery, china, ornamental work, cast iron railings, stoves, carpets, rugs, linoleum, wall paper, stencils, dress fabrics, lace, embroidery, neck-

ware, umbrella handles, jewelry, brooches, silverware, knife, fork and spoon handles, belt buckles, hat pins, book covers, tail pieces, toys souvenirs, trade marks and many other lines of work.

It is hoped to publish drawings of these motives as soon as the drawings can be made. Each drawing will be labeled as to what the specimen is, where it was found, where it is now, its size, material, and, to a certain extent, with the region in which the type of motive is found. The area in which each motive is found is given, so, for instance, that a British Columbian manufacturer may know which motives are appropriate for British Columbian manufactures rather than use one appropriate only for Manitoba. Some of these areas extend into the United States as does the area of the maple leaf and the beaver; others are confined to parts of Canada. Reference is made to photographs, lantern slides, and published illustrations wherever such exist. The actual specimens are scattered in this museum, the Provincial Museum at Toronto, Provincial Museum at Victoria, the Museum of the Natural History Society, St. John, New Brunswick, the Provincial Museum at Halifax, the American Museum of Natural History, New York, the Museum of the University of Pennsylvania, the British Museum and museums in San Francisco, Florence, Italy, Berlin, Germany and elsewhere.

If this publication is issued it will no doubt be sent to every large library, every member of Parliament, every newspaper in Canada, probably, to all Canadian manufactures using designs and certainly to all such manufacturers who express the need for it.

As it may be months before all the drawings can be made the archeological office will make every effort to give free of all expense any practical aid that it can in the use of these motives. These data are at the service of any manufacturer who desires to call at the office. Possibly photographs can be made of a few of the motives for such manufacturers as specify just what they would like to have photographed. A typewritten list of the books containing pictures of some of the specimens will be supplied on request.

The office will do all in its power to hasten this work and will be obliged to manufacturers if they will call or write to offer suggestions and express their needs. Such an expression will very likely be of service to the office in securing the improvement and hasty publication of the album of motives.

HARLAN I. SMITH
GEOLOGICAL SURVEY, CANADA

METHODS AND MATERIALS FOR THE PREPARATION OF WALL CHARTS

VARIOUS grades of paper, with or without cloth-backing, have been used extensively for many years in making charts to be used in lecture rooms. However, unbacked paper does not wear well, and cloth-backed paper is heavy and stiff, besides being expensive.

Shade cloth is cheaper, lighter, and much more durable than any chart paper. One variety known as Holland Shade Cloth is used by several workers in my acquaintance. A large chart of this cloth may be folded into a small package or rolled into a close roll convenient for carrying in a suit case to a meeting in some distant city. When unpacked it requires no heavy sticks to make it hang smoothly.

This cloth furnishes a fine surface for line drawings. The air brush may be used on it in shading, and wax crayons may be employed. However, when large areas of wash shading with a brush are involved, there is a good deal of puckering of the cloth. For this reason, I have made trials of other fabrics in the past three years, and I have found that so-called Peerless Cambric Shade Cloth, Ivory White, is excellent for large wash drawings. It does not pucker noticeably, and it has a good drawing surface. There is no trouble with "drying lines" in applying washes. This cloth is a little heavier and stiffer than Holland cloth, and it can not be packed so compactly without forming creases. I have recently been informed that the puckering may be avoided by mixing equal parts of 80 per cent. alcohol and the ink solution employed.

I have not found it practicable to erase ink

marks from shade cloth to any extent, but lead pencil marks are more easily removed than from paper. When a mistake is made with ink that can not be erased, I find it best to paste a bit of the shade cloth over the error. This is not noticeable at the distance of even the front row, in any ordinary lecture room.

For making lines, I find so called round-writing pens (single pointed) better than a ruling pen as it is hard to make lines broad enough with the latter instrument. Round writing pens may be obtained in different widths, and they are inexpensive. The wider pens are useful especially for making bold strong lines to be seen in a lecture room of some size.

Most of my charts are made with water-proof inks of the best grade. These are kept in various dilutions in a series of one-ounce bottles. Thus I keep about six dilutions of black ink in as many bottles labelled one to six, for use in neutral gray shading. A few drops of black ink in an ounce of water make a dark shade. Several drops of this added to an ounce of water in another hottle make a weaker solution, and so on according to the eye of the user.

I dilute the colored inks usually by placing a few drops of ink in an ounce of water, according to the color desired. Many varieties of color shade and tint may be obtained by mixing colors in water and by adding a little much-diluted black ink to a colored solution in varying proportions. It is my practise to dilute almost all of the ink used, to some extent. Softer and more pleasing effects are produced, and the ink goes farther. It is also more easily applied.

For class use and for convenience in storing, I find it desirable to have charts mounted. Two half-round pieces of one inch diameter are glued together with the lower end of the chart between their flat surfaces. To make the binding still more secure, nails are also used. Light one-half-inch half-round material is used for the top in the same way. Straps for hanging, of strong braid one half to three quarters of an inch wide and a foot or so long are fastened to the top strips at suitable places. These also serve in the usual way for tying the charts up when rolled. It is particularly important that the straps be attached strongly.

Some readers of this article may not be familiar with the possibilities of a pantograph in copying small drawings enlarged on charts. The best pantographs are expensive, and the cheapest unsatisfactory. However, I have found one costing about $5.00 of considerable service. It enables one to get the general outlines of the drawing, but these must be corrected by free-hand work later.

Neat labelling, that can be read in the rear seats of the room in which the chart will be used, is exceedingly important. It is my practise both with charts and lantern slides to avoid any details in either labelling or drawing that can not be distinguished easily in the more remote parts of any lecture room in which the illustrations are to be used.

It is distressingly common, especially when lantern slides are employed, to find this rule violated. Large sheets of typewritten material are often crowded into a lantern slide with the result that they can be read only when very near the screen, if at all. In the case of lantern slides, any details which can not be distinguished easily in the slide will also be too minute on the screen. In preparing charts it is a good practise to put letters and drawing details of various sizes on a blackboard which may be viewed from the most distant seats in order to determine the most practicable proportions.

Labelling may be quickly and neatly done with the aid of the so-called sign-painters' rubber stamps. Sets may be bought in various sizes and with both caps and small letters as well as Arabic figures, etc. Inks of various colors may be obtained for the stamping. Quick-drying inks save time in the preparation of a chart.

It is my experience that most and sometimes all the chart work described in this article can be done by student service under direction, especially if students who draw well are available.

Though I am reluctant to appear to advertise dealers, for the convenience of readers I think I am warranted in stating where the materials mentioned in this article may be purchased. The shade cloths may be purchased from the Remien and Kuhnert Co., 61 W. Grand Ave., Chicago. In September, 1916, I was given a price of 38 cents per yard for "Peerless Cambric Ivory White" shade cloth, 48 inches wide in entire rolls. The price was 44 cents per yard in small quantities. The White Holland shade cloth was slightly cheaper. Dr. G. R. LaRue, of the University of Michigan, has informed me recently that "Linaura Chart Cloth" sold by the Williams, Brown & Earle Co., Philadelphia, is very satisfactory.

For labelling, we are using a so-called "Sign and Price Marker" set, No. 48 in catalogue No. 28 of Meyer and Wenthe, 108 N. Dearborn St., Chicago. The catalogue price is $5.00 for the complete set. It is adapted to charts to be used in large lecture rooms. Set No. 6 at $4.00 and set No. 4 at $2.50 are recommended for smaller rooms. The round writing pens can probably be bought at many art and drafting instrument stores. Mine were obtained of A. H. Abbot and Co., 119 N. Wabash Ave., Chicago, ½ gross for 25 cents.

R. M. STRONG

ANATOMICAL LABORATORIES,
VANDERBILT UNIVERSITY MEDICAL SCHOOL

THE ELEMENTARY TREATMENT OF FORCE

THE discussion by G. S. Fulcher in SCIENCE, XLIV., 747, 1916, concerning some of the errors and inconsistencies in our elementary texts regarding the questions of force and Newton's laws of motion, are most timely. No doubt many of us who are trying to build up in the minds of our beginning students a sound structure of physical ideas, and above all, are hoping through physics to give them something of the scientific attitude, have almost despaired of finding a text which is free from the faults mentioned. To approach the ideal, a text should be brief in its statements but so explicit as to allow of but a single interpretation; it should not anticipate knowledge which obviously the beginning student does not possess, nor should it attempt to circumvent this deficiency by repeatedly referring the student to articles further along; it should, in fact, be written upon the premise that the only source of physical ideas which the average beginning student of physics has is his own experience.

In introducing force, therefore, all speculation and conjecture, made in the light of the author's own familiarity with the subject, is decidedly out of place, and can serve only to confuse the student. It should be presented to him primarily in terms of his immediate impressions, *i. e.*, in terms of his muscular sense. Let us tell him first that "force" is the term applied to the equivalent of a push or a pull. The average student has pretty clear ideas as to what such an action can accomplish. It is then not difficult to represent Newton's first law as a test for the absence of a force, nor the second law as a test for its presence. After familiarity with these notions has been gained, we can further represent the second law as a quantitative test for force, and can show how we can experimentally establish the relation $f = ma$. This may then be regarded as a more exact definition of force, derived from our observations upon objects external to ourselves. In all of this discussion it is of greatest importance to emphasize by repetition the fact that *whenever a force is exerted, two bodies are involved: A, the body acting, and B, the body acted upon.*[1] This is one of the outstanding

[1] In his reply (SCIENCE, XLV., 480, 1917) to A. H. Patterson (SCIENCE, XLV., 259, 1917), which was printed after the present paper had been submitted for publication, Dr. Fulcher has already emphasized this point.

In this connection, may I suggest that we discontinue the use of the phrase, "a force acts upon . . .," which is so exceedingly common in our texts? It seems to me that the phrase attributes to force a property which it does not possess. Why not be unequivocal and say "a force is exerted upon . . ."? This latter way of stating the fact serves better than the former in keeping the above italicized principle before the student, in that it deprives the notion of force of that seeming independence which does not pertain to it.

points which have been disregarded in our texts. The result has been that in a large number of cases the student did not see *how* the force was being exerted; he felt that there was an intangible something about force beyond the range of his ability to grasp. It is small wonder that rapidly increasing confusion results from this lack of self-confidence.

Another point can not be too strongly emphasized. No author of an elementary text seems as yet to have recognized the importance of distinguishing most carefully between forces of action and forces of reaction. It seems to me of prime importance, if the student's ideas about force are to be sharply outlined, to make this distinction. I would suggest that it lends facility to the treatment to use the terms "applied" force and "reactive" force for forces of action and of reaction, respectively. The following treatment may bear out the contention concerning the importance of recognizing both.

Let us first apply Newton's third law of motion to the case of a body A, acting upon a fixed body B. In this case the student readily understands that B exerts a reactive force equal and opposite to the applied force exerted by A; for if this were not true, motion should ensue in accordance with the second law. He also readily sees that the reactive force arises and ceases simultaneously with the applied force. Often, however, when the third law is applied to a movable body B, and the student is told that the accelerated B exerts a reactive force upon A, equal and opposite to the applied force exerted by A, he is dubious and asks: "If that is true, how can there be an acceleration? By the first law, B should then remain at rest or in uniform motion." With the distinction between applied and reactive forces clearly drawn, this question can not arise. In this particular case we may point out that, to be sure, no acceleration of B could occur if the force exerted by A upon B were opposed by another applied force, exerted upon B in the opposite direction by a third body, C. However, since there is only the one applied force, that due to A, acceleration must ensue in accordance with Newton's second law; and, *simultaneously with this acceleration, ergo, with the applied force, there arises the reactive force of B upon A.* We may, to present the case somewhat more tangibly, speak of the applied force as being exerted by that particular body which, so to speak, takes the initiative in the processes. It is well to point out, further, that the reactive force of B upon A arises regardless of whether the motion of B is in the direction of the force exerted by A, or whether there is a finite angle between these two directions. If this angle is a right angle, the applied force causes B to move in a circular path, without change in speed; the applied force is then called centripetal. The reactive force exerted by B upon A under these conditions is called the centrifugal force, which disappears at exactly that instant which marks the disappearance of the applied force. Numerous examples to illustrate these statements will occur to the teacher.

If the student is familiar with the above principles, the problem of Atwood's machine becomes very simple. For here considering the moving system as a unit, the applied force of A (the earth) upon B (the system) is obviously $(m_2 - m_1)g$; the reactive force of B upon A is $(m_2 + m_1)a$. These, by the third law, are equal. The value of a, or of g, immediately follows from the equality.

I can not quite agree with Dr. Fulcher that the failing of our authors in treating reactive forces, especially centrifugal force, as they do, is because of "their forgetting that these forces are purely imaginary." Is it not rather attributable to their previous neglect in not having emphasized the difference between applied and reactive forces?

Just an illustration, in conclusion, to show that American writers do not alone fall under the criticism of giving insufficient thought to the presentation of some of the fundamental things. We find, for example, in a German text, widely used in the Realschulen, by an author reputed to have been one of the foremost teachers of physics, a treatment as follows: "Upon the liquid particle A there are acting two forces, the force of gravity, ver-

tically downward, and the centrifugal force, acting horizontally. . . . The resultant is found by the parallelogram law. Its direction must be normal to the surface of the liquid." Had this author, and our American authors, been careful to draw the distinction between applied and reactive forces, they could not easily have fallen into the error of combining an applied force with a reactive force and obtaining—what kind of a force? Whatever the kind, it can not be an applied force; for if it were, it should, according to the second law, produce an acceleration in its own direction. But such an acceleration, as pointed out by Dr. Fulcher, does not here exist.

There are many other fundamental questions in physics about the best method of presentation of which we are not agreed. Teachers of college physics should welcome the opportunity of discussing them, and by so doing, clearing up their own ideas about them. Perhaps, also a thoroughly satisfactory text might thereby be evolved.

PAUL E. KLOPSTEG
UNIVERSITY OF MINNESOTA

QUOTATIONS

ROYAL SOCIETY FELLOWSHIPS

A QUESTION of more than ordinary interest and importance is involved in the opposition of a majority of the Fellows of the Royal Society to a proposal of its council to amend the statute of the society governing the election of fellows. On June 7 a special general meeting of the Royal Society was held, as the result of a petition to the council, to consider a proposal by the latter embodied last year in their report for 1916. It was to amend Statute XII. by empowering the council to recommend for election (*a*) privy councillors "whose election would assist the work of the society"; and (*b*) "men distinguished in the scientific or educational service of the state, or by their services to science and its applications." The opposition to this proposal, led by Sir David Bruce and Sir E. Ray Lankester, had been energetically whipped up among the unofficial fellows since last November, and there was an unusually large attendance at the meeting. The result was that a vote was taken, adverse by a considerable majority to the council. The following resolution was carried: "That this meeting is of opinion that the council will serve the best interests of the society by restoring Statute XII. to the form it had before the change made in it by the council on November 2, 1916, and by postponing further consideration of the statute relating to the election of fellows until after the termination of the war." The precise effect of the action thus taken by a majority of the fellows is for the moment rather uncertain, and the position is a somewhat embarrassing one for the president and council, who have thus suffered an apparent rebuff. According to the constitution of the Royal Society, the power of making and amending its statutes resides solely in the council, so that, strictly, the resolution is a *brutum fulmen*. On the other hand, the actual election of fellows rests with the society, and the council can only recommend candidates. So that the council is hardly likely to provoke an unseemly opposition to candidates it might recommend for election under the amended statute—even if it declines to stultify itself by "restoring" the *status quo ante* as suggested—by flying in the face of the adverse vote.

We understand that the president and council were, in fact, quite ready to meet the opposition raised within the society so far as concerns a postponement of any action on the amended statute till after the war. And in the comment we propose to make we can not, partly for that reason, express our entire disagreement with the opposition too strongly at this juncture. At the same time we think it desirable to say at once that we think the hostility of so many fellows to a proposal intended to increase the prestige and the value of the Royal Society distinctly regrettable. It was based, we are well aware—at any rate among some of the more eminent fellows who led the opposition—largely on suspicions of the introduction of state patronage into scientific research. But we have no doubt also that the influence of "vested interests" in the existing system of election to the coveted distinction of

F.R.S. has been even more potent in securing the majority against the proposal of the council. What we are quite certain about is that for a long time past the elections to the fellowship of the Royal Society have (largely through this influence of "vested interests") got far too much into a groove. The honor of being labelled F.R.S. has gradually come to be regarded more and more simply as a higher "degree" added to the academic distinctions of men who have passed through the regular scientific "mill" and have contributed a certain number of papers to the *Transactions*. The result is that the Royal Society is not as fully representative as it ought to be of the genius of the country, to which, as in earlier days, its fellowship should be extended. This is particularly true of "men distinguished in the scientific or educational service of the state," the importance and originality of whose work for the nation have secured much more adequate appreciation in consequence of the light thrown on it during war-time. A more elastic procedure in the recommendations to fellowships has for some time past been seen to be called for by the wisest heads in the society, and the proposal of the council was the outcome. We hope that it will still be pushed, with more persuasive effect, even though for the moment nothing further is done.

NOTES ON CANADIAN STRATIGRAPHY AND PALEONTOLOGY

CORDILLERAN PROVINCE

Graham Island.—The Queen Charlotte Islands form part of the outer, largely submerged ranges of the northwestern Cordillera and are generally considered to be the northern continuation of the Vancouver Range. Graham Island is the largest and one of the most northerly of the group. Its geology is the subject of a memoir by MacKenzie.[1] The oldest rocks exposed on the island belong to the Vancover group and are divided into two formations, the Maude and the Yakoun. The former consists of argillites, sandstones, and tuffs; it contains a marine fauna of early Jurassic age and at two localities in the lower beds are "probably Upper Triassic" forms. The Maude formation contains a large amount of pyroclastic material in its upper portion and grades upward into the Yakoun volcanic agglomerate, composed of rather massive water-laid beds. Its marine fauna, largely pelecypods and ammonites, suggests correlation with Middle Jurassic sandstones in Alaska. Both formations are moderately metamorphosed and considerably disturbed by folds and faults. They are cut by batholithic intrusions which may be correlated with the Upper Jurassic Coast Range batholith. The orogenic movements causing the deformation of the Vancouver group manifested themselves as compressive stresses acting in a direction north 60° east and were concomitant with these intrusions.

Erosion during Comanchean time reduced the mountain ranges thus formed to a subdued topography which was buried beneath the Queen Charlotte series in the Cretaceous period. That series consists of the Haida sandstones and coal-bearing shales, the Honna conglomerates and sandstones, and the Skidegate sandstones and shales, named in ascending order. It is probable that the Queen Charlotte series was formed in estuarine basins by the sudden influx of a large amount of sediment carried in by rapid streams, and that the series as a whole represents a delta deposit reassorted and modified by the waves and currents of a shallow sea. During the Laramide revolution the rocks of this district were slightly folded and upraised; dacite and andesite dikes and sills were extensively injected. Following this uplift, the Cretaceous sediments were largely stripped from the underlying rocks, remaining only in synclinal basins.

Shallow-water sediments forming the Skonun formation were deposited during the Miocene period. Sedimentation was cut short by the resumption of volcanic activity on a tremendous scale, by which the Masset formation was built up. This vulcanism is best placed in the early or mid-Pliocene, and the close of this epoch was marked by a recur-

[1] J. D. MacKenzie, "Geology of Graham Island, B. C.," Geol. Surv., Canada, Mem. 88, 1916.

rence of deforming forces which locally severely flexed the Tertiary formations but in general disposed them in broad open folds. Quaternary time has been marked by erosion, glacial as well as fluvial, and there are some suggestions of a recent, slight, negative movement of the strand line.

A valuable correlation table of formations of Graham Island and neighboring districts faces page 118 of this excellent report.

Flathead Valley.—The Flathead coal basin, occupying a portion of Flathead Valley in British Columbia near the international boundary, is described in another memoir by the same author.[2] Bedrock formations range from strata which are probably Devonian to those of Eocene age. At the base are black limy sandstones and shales which have not yet yielded identifiable fossils but are referred to as "Devono-Carboniferous." Grey and black limestones conformably overlie the shales and range in age from Upper Mississippian to Lower Pennsylvanian, according to Girty's interpretation of two lots of fossils obtained from the middle and near the top of the formation. Above these limestones a white, quartzose sandstone was found. It is provisionally referred to the Triassic because of its position beneath the Fernie shales which elsewhere have been proved to be of Jurassic age. (The lithologic similarity between this Triassic (?) sandstone and the Jurassic La Plata sandstone of Colorado is noteworthy.) The Fernie formation is conformably overlain by the coal-bearing Kootenay sandstones and shales. The Kootenay beds were "accumulated in a long lake of varying depth, or, more probably, in a chain of lakes and swamps extending along what is now the axis of the Rocky Mountains." They are of Lower Cretaceous (Comanchean) age. Upper Cretaceous conglomerates and sandstones are believed to represent the Dakota formation. Orogenic disturbance during the Laramide revolution was followed by the deposition of the Kishinena formation during Tertiary time. The Kishinena beds are of freshwater origin and may be of Eocene age.

[2] J. D. MacKenzie, "Geology of a Portion of the Flathead Coal Area, British Columbia," Geol. Surv., Canada, Mem. 87, 1916.

CAMBRIAN

Trilobites.—A recent number[3] of Walcott's memoirs on Cambrian Geology and Paleontology contains descriptions and figures of several trilobites, some of them new, from the Lower and Middle Cambrian of Newfoundland, Quebec, Alberta, and British Columbia. *Corynexochus senectus* serves to correlate the upper beds of the *Olenellus* series of Newfoundland with the top of the Mount Whyte formation in the Lower Cambrian of British Columbia. A new subgenus of *Corynexochus* is named *Bonnia,* and to it are referred two closely allied species, one from the Mount Whyte formation and the other from the Lower Cambrian of Labrador and Quebec. To the genus *Bathyuriscus* are referred a new species from the Stephen formation near Field, B. C., and a new subgenus, *Poliella,* which comprises several small-tailed trilobites. Most of them are of Middle Cambrian age, but one occurs in the Mount Whyte formation and lived near the close of Lower Cambrian time. *Dolichometopus* and *Ogygopsis* receive thorough treatment and *Olenellus gilberti* is transferred to the genus *Mesonacis* on the basis of data derived from a Mount Whyte specimen. A new genus, *Pagetia,* is founded upon material from the Burgess shale member of the Stephen formation near Field.

New Brunswick.—A brief but important paper by G. F. Matthew[4] contributes to knowledge of the paleogeography of eastern Canada in early Cambrian time. The relations of Cambrian rocks in New Brunswick are presented in tabular form. At the base is found the non-fossiliferous Coldbrookian terrane, composed largely of volcanic rocks, overlain by the Etchiminian slates and sandstones with a scanty fauna of *Hyolithes* and *Obolus.* The overlying Acadian division of the St. John group is much more extensive because

[3] C. D. Walcott, "Cambrian Trilobites," Smithsonian Misc. Coll., Vol. 64, pp. 303–456, 1916.

[4] G. F. Matthew, "Notes on Cambrian Faunas," No. 12, *Trans. Roy. Soc. Canada.,* Ser. 3, Vol. 10, Sec. 4, pp 45–54, 1916.

of sea transgression. The lower fifty feet of this division contains the *Protolenus* fauna which Walcott interprets as marking the passage beds between Lower and Middle Cambrian. Above are shales and slates, 200 feet thick, carrying the *Paradoxides* fauna. The middle division, Johannian, of the St. John group consists of coarse clastics characterized by the presence of *Lingulella,* while the upper one, Bretonian, is largely dark gray to black shale which is in part of Ordovician age.

Emphasis is laid upon the complete separation of the Atlantic coastal seas from those of the interior of North America during early Cambrian time, and "the presence of a deep and broad abyss off the Atlantic coast in this early time" is postulated.

Ontario.—The Potsdam sandstones which outcrop in the vicinity of Kingston are described by M. B. Baker[5] in a report which in the main treats of pre-Cambrian geology. Two members, a lower buff, and an upper red sandstone, are recognized as forming the Potsdam formation. Both were deposited in the basins and hollows between low rounded hills of pre-Cambrian rock. Basal and other conglomerates are common. Cross-bedding is frequently observed and the strata are non-fossiliferous. The so-called "tree concretions" are interpreted as structural accumulations resulting from whirlpools and eddies.

ORDOVICIAN

Ontario.—Fossils from the Trenton limestone in the the Balsam Lake region are described by Ruedemann.[6] A new species of graptolite is referred to the genus *Inocaulis.* Unusualy well-preserved specimens of *Stenaster salteri* confirm the suspicion that this

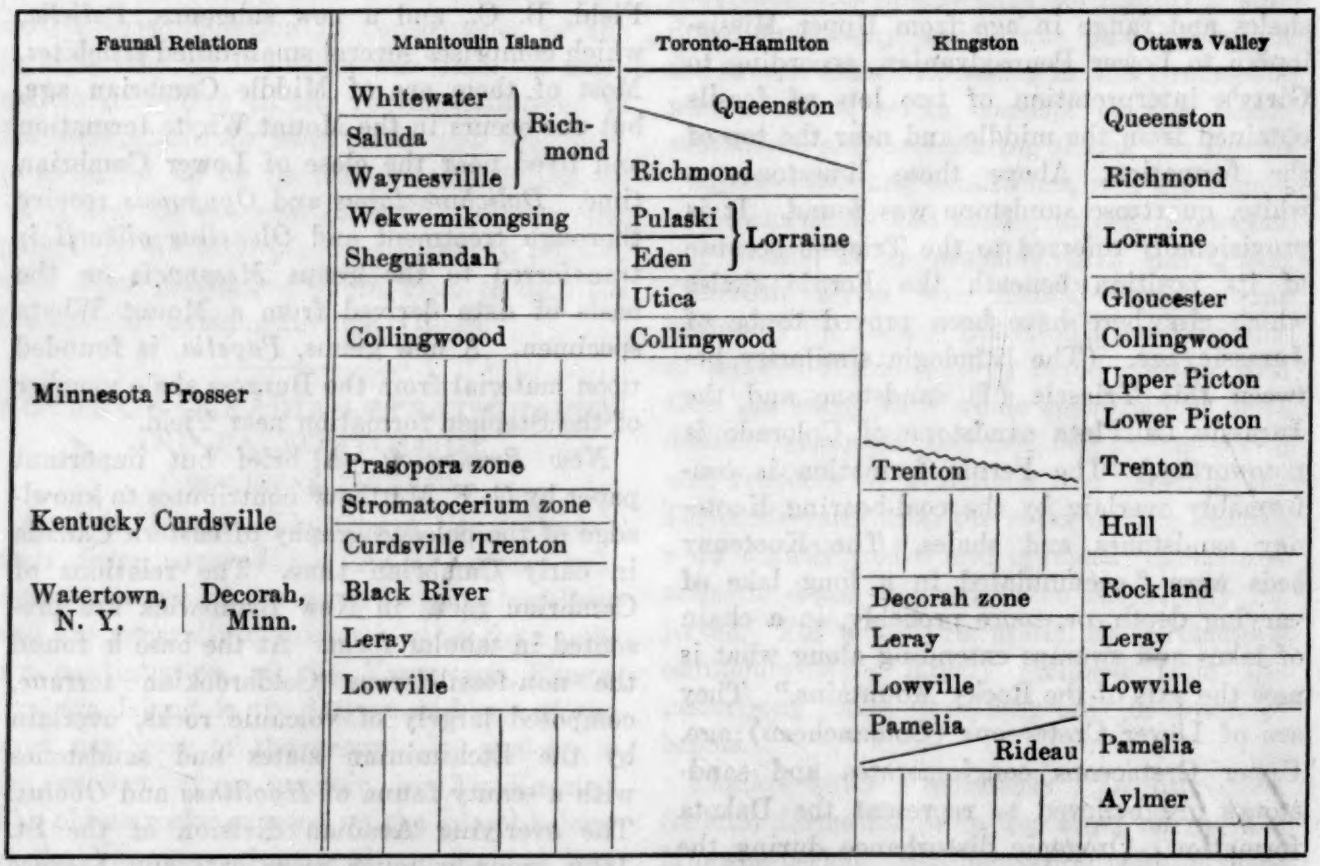

Fig. 1. Correlation chart of Ordovician strata in Ontario. Compiled from papers by Foerste, Parks, Kindle and Raymond.

[5] M. B. Baker, "The Geology of Kingston and Vicinity," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 1–36, 1916.

[6] R. Ruedemann, "Paleontologic Contributions from the New York State Museum," New York State Mus. Bull. 189, 1916.

remarkable stelleroid belongs to the subclass Auluroidea. It is believed to be a primitive ophiuroid, which was still very close to the ancestral asterozoans.

The Ordovician strata of Ottawa Valley are described in summary style by Raymond.[7] The formational nomenclature and relationships are indicated in the accompanying table. Gloucester is a new formation name applied to the carbonaceous shales between the Collingwood and Cincinnatian strata. In correlating the Ottawa formations with those of New York, Kentucky, and Minnesota, Raymond makes a number of radical departures from the conclusions of Ulrich and Bassler. In certain details, the correlation chart[8] is not in complete harmony with the statements made on the accompanying pages of text, as, for example, in regard to the faunal relations of the Kentucky Curdsville.

The limestones of the Kingston district are described by Kindle.[9] The formations recognized are indicated in Fig. 1, which departs from Kindle's usage only in the separation of the Decorah zone as a distinct stratigraphic unit above the Lowville-Leray. The term, "Rideau," originally proposed by Ami[10] in terms which, in the reviewer's opinion, include the Potsdam sandstone described by Baker as noted above, is applied to the green-tinged, arkosic and generally conglomeratic, shaly beds at the base of the Pamelia formation. Accompanying the description of Ordovician strata is a report upon their faunas by Miss Wilson and K. F. Mather.[11] Faunal lists and descriptive keys to the common fossils are aranged in two parts, one for the Black River and the other for the Trenton rocks.

Quebec.—The district about Lake St. John at the head of Saguenay River in Quebec is of interest to the stratigrapher because of the occurrence of Paleozoic sediments far within the limits of the Pre-Cambrian "shield" of northern Canada. These outliers, described by Dresser,[12] are preserved in a basin formed by normal faulting which may have occurred at the close of the Paleozoic Era. The sediments include Trenton limestone, Utica shale, and Richmond limestone, said to be "deposited in conformable succession."

Fossils from the Trenton and Utica were identified by Raymond. The Trenton fauna is preponderantly molluscan and is probably basal Trenton, "about the horizon of the Rockland beds of the Ottawa district." The Utica fauna is small and not distinctive. According to Foerste, the Richmond faunas correspond to those of the Waynesville member of the Ohio Richmond.

SILURIAN

A star-fish from the Arisaig series at the mouth of Stonehouse brook, Nova Scotia, is described by Ruedemann[13] as a new variety of *Urasterella ruthveni* of the Upper Ludlow in England.

DEVONIAN

E. M. Kindle[14] records the occurrence of limestones containing a Devonian coral at Gull Lake, in the lower MacKenzie Valley, where published data show only Cretaceous and pre-Cambrian terranes. Two other small collections of Devonian fossils from MacKenzie Valley, one from within the Arctic circle, are commented upon.

[7] P. E. Raymond, "The Correlation of the Ordovician Strata of the Baltic Basin with those of Eastern North America," Harvard College Mus. Comp. Zool., Bull., Vol. 56, pp. 179–286, 1916.

[8] Raymond, *op. cit.*, p. 257.

[9] E. M. Kindle, "The Ordovician Limestones of the Kingston Area," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 37–44, 1916.

[10] H. M. Ami, "Ordovician Succession in Eastern Ontario," Geol. Soc America, Bull., Vol. 13, pp. 517–518, 1902.

[11] Alice E. Wilson and Kirtley F. Mather, "Synopsis of the Common Fossils of the Kingston Area," Ontario Bur. Mines, Ann. Rept., Vol. 25, Pt. 3, pp. 45–66, 1916.

[12] J. A. Dresser, "Geological Structure of the Basin of Lake St. John, Quebec," *Trans. Roy Soc. Canada*, Ser. 3, Vol. 10, Sec. 4, pp. 125–130, 1916; "Part of the District of Lake St. John, Quebec," Geol. Surv., Canada, Memoir 92, 1916.

[13] *Op. cit.*, p. 46.

[14] E. M. Kindle, "Notes on Devonian Faunas of the MacKenzie River Valley," *Am. Jour. Sci.* (4), Vol. 42, pp. 246–48, 1916.

CARBONIFEROUS

R. L. Moodie[15] reprints, in his monograph of Pennsylvanian amphibia, descriptions and figures of the remarkable microsaurs from the Joggins coal fields in Nova Scotia, which were published by Dawson between 1860 and 1895.

TRIASSIC

L. M. Lambe[16] has published descriptions of three new fishes, two Paleoniscids and one Crossopterygian, from localities west of Banff. The strata have heretofore been assigned to the Jurassic period[17] but are more correctly correlated with the Upper Banff shale on the basis of invertebrates associated with the fish remains. The Upper Banff fauna, according to Girty and Kindle, represents the horizon of the Lower Triassic Meekoceras beds of Idaho and Wyoming. It should no longer be referred to the Permian.

CRETACEOUS-EOCENE

The geology of the region about Wood Mountain and Willowbunch, adjoining the international boundary south of Moosejaw, Sask., is described by Bruce Rose.[18] The strata exposed range from the Fox Hills and Pierre Cretaceous through the Lance formation to the Fort Union Eocene. The latter contains lignitic coal of value. An excellent description of the Prairie Plains of Saskatchewan and their Quaternary history forms the second chapter of the report.

New types of duck-bill dinosaurs from the Cretaceous of Alberta are described by Brown.[19]

[15] R. L. Moodie, "The Coal Measures Amphibia of North America," Carnegie Inst. Washington, Pub. 238, 1916.

[16] L. M. Lambe, "Ganoid Fishes from near Banff, Alberta," *Trans. Roy. Soc. Canada,* Ser. 3, Vol. 10, Sec. 4, pp. 35–44, 1916.

[17] J. A. Allan, "Bankhead to Golden," Cong. géol. internat., Guide Book 8, Pt. 2, p. 191, 1913.

[18] Bruce Rose, "Wood Mountain-Willowbunch Coal Area, Saskatchewan," Geol. Surv., Canada, Mem. 89, 1916.

[19] Barnum Brown, American Mus. Nat. Hist., Bull., Vol. 35, pp. 701–708, 1916.

MIOCENE

A new species of cyprinid fish, based upon four specimens discovered by Bruce Rose of the Canadian Geological Survey near Kamloops Lake, B. C., is described by Hussakof.[20] It has considerable resemblance to *Leuciscus balteatus* living to-day in the Columbia basin.

Kirtley F. Mather

Queen's University,
Kingston, Canada,
March 5, 1917

SPECIAL ARTICLES

THE VITALITY OF CYSTS OF THE PROTOZOON, DIDINIUM NASUTUM

It is well known that many of the unicellular forms encyst under certain conditions, *i. e.,* become inactive and form a heavy wall about themselves, and that in this state they can endure environmental conditions which are otherwise fatal. For example, the loss of water readily kills didinia when they are in the active state, but when they are encysted desiccation such as is produced by exposure even for months to ordinary atmospheric conditions does not necessarily kill them. This is also true of many other forms. When they are thus dried they may be widely scattered by the wind; encystment consequently may have a twofold function, protection and distribution. Whether or not it functions still further in rejuvenescence in accord with the contention of Fermor (1913) and Calkins (1915) is a question which will be considered at some length in a later paper.

The degree of protection and the extent of distribution that organisms secure by encystment depends upon the vitality of the cysts. The longer they live the greater the protection and the wider the distribution. It is consequently important to know how long organisms can live in the encysted state. This is especially true regarding pathogenic forms, and these forms are the only ones, with the exception of the rotifers, in which the problem has been seriously investigated. Knowledge regarding the endurance of cysts

[20] L. Hussakof, "A New Cyprinid Fish, *Leuciscus rosei,* from the Miocene of British Columbia," *Am. Jour. Sci.* (4), Vol. 42, pp. 18–20, 1916.

may also throw some light on the nature of protoplasm in that it gives information concerning the lower limit of metabolism necessary for life.

In a series of experiments made in connection with other work on *Didinium* described elsewhere, it was found that the cysts live much longer than had been anticipated. On June 11, 1910, several didinia, all derived from the same individual, were put into a 100 c.c. beaker containing 50 c.c. of solution with numerous paramecia. The beaker was then placed in a damp chamber and left until January 15, 1911. At this time many didinia cysts were found in the beaker, and no active organisms except a few rotifers. It is not known just when these cysts were formed, but, judging from what usually occurs under similar circumstances, they were probably all formed within a week after the didinia had been added to the culture of paramecia, *i. e.*, about the middle of June, 1910.

On May 31, 1911, a 10 c.c. vial was filled with solution from the beaker containing about one half the cysts. The vial was then corked, sealed airtight with paraffin and laid away in a dark drawer. The remaining cysts were added to a portion of a vigorous culture of paramecia, and the rest of this culture was retained as a control. Two days later there were several didinia in the portion seeded with cysts, none in the control, showing that the cysts were still viable. A few cysts were removed from the vial and similarly tested on each of the following dates: October 22, 1912; January 23, 1914; December 12, 1914; January 7, 1915; March 1, 1915, and March 4, 1915. In all of these tests except two, December 12, 1914, and January 7, 1915, active didinia were secured from the cysts. No didinia were found in any of the control cultures. This proves conclusively that the cysts of *Didinium nasutum* can live, at least, nearly five years.

In all of the tests observations were made daily. In the test of October, 1912, active didinia were found on the fifth day after adding paramecia, in those of January, 1914, on the second day, and in those of March, 1915, on the sixth and tenth days respectively.

In each of these tests, except the first two and the last, four watch glasses containing cultures of paramecia were seeded with the cysts. In the last test, March 4, 1915, all of the remaining cysts were added to two liter jars containing vigorous cultures of paramecia. In the test of January, 1914, didinia appeared in three of the watch glasses, in those of December, 1914, and January, 1915, in none, although observations were made for more than two weeks; in those of March 1, 1915, active didinia appeared in only one of the four watch glasses; but in the last test of the series they appeared in both jars. In one of these jars only a few small specimens were found and these soon died out; in the other, however, the didinia appeared to be perfectly normal; they developed rapidly and produced a vigorous culture which is still in existence, February, 1917.

It is thus evident that some of the cysts were still viable at the close of our experiment, which extended through nearly five years, but it is not clear how much longer they could have remained viable. However, at the close of the experiment the cysts were much shriveled, only partially filled with protoplasm, and yellowish in color, whereas in the beginning they were well filled with protoplasmic granules and grayish in color. Toward the close of the experiment the proportion of failures was also much larger than at the beginning. All this indicates that the cysts would probably not have lived much longer. On the other hand only a very small proportion of the cysts developed in any of the tests, probably not more than two per cent. Consequently, since the cysts became less numerous as the experiment proceeded the large proportion of failures toward the close may have been due to an insufficient number of cysts rather than to their age.

We have thus demonstrated conclusively that didinia in the encysted state can live nearly five years in a solution from which they probably get nothing in the nature of food. If the cysts are dried they probably

live even longer than they do in a solution as the results of the following series of experiments show.

Early in the spring of 1910 ten eight-liter battery jars nearly full of solution containing numerous didinia were set aside in the laboratory. Eight of these jars were covered and two were left uncovered. The solution of one of these contained much débris, hay, etc., that of the other almost none. The solution in both evaporated gradually, so that on the last day of May there was only a trace of moisture left in either jar. When they were next examined early in August the debris was so dry that it could be readily crumbled between the fingers.

On January 14, 1911, one half of the solution in each of the eight jars was poured off and replaced by hay solution (1 gm. hay to 200 c.c. water boiled ten minutes), and the two empty jars were half filled with the same solution. All of the jars were then examined from time to time until February 10. Active didinia were found in only one of the jars, and this was one of the open jars, the one which contained much debris. Several active didinia were found in this jar January 17 and more later. Numerous colorless flagellates, some vorticellæ and also a few other forms appeared but no paramecia.

The results of these experiments, consequently, clearly indicate that the vitality of dried cysts is greater than that of wet cysts. The number of cultures tested was, however, so small that the siginficance of the results obtained is somewhat doubtful. The tests should be repeated and extended in connection with a study of the histological changes that may occur in the cysts.

S. O. Mast
The Johns Hopkins University

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 121st regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 P.M., May 1, 1917, with thirty-nine members present. Mr. Burt A. Rudolph, Mr. Glenn C. Hahn and Mr. Horace W. Truesdell were elected to membership.

The regular program was devoted to a symposium on the flora of the District of Columbia. Professor A. S. Hitchcock discussed "The plan of the flora" and traced briefly the history of the flora from Brereton's studies in 1831 to the present time. In 1906 a mimeograph list of the vascular plants was prepared by Mr. P. L. Ricker. The flora is now under the leadership of Professor A. S. Hitchcock and Mr. P. C. Standley. Twenty-five collaborators are now at work preparing the preliminary manuscript which is to be finished by June 1 and the manuscript completed by November 1, 1917.

Mr. Edgar T. Wherry, at the invitation of the society, furnished a paper on "Geological areas about Washington." The paper was read by Mr. Hitchcock. The prominent geological feature is the Fall Line which separates the Piedmont Plateau on the northwest from the Coastal Plain on the southeast. Above this line the valleys are steep-sided, and below broad and open. The Piedmont Plateau consists chiefly of crystalline gneisses of early periods, while the Coastal Plain is occupied by unconsolidated gravels, sands and clays. The soils on the Coastal Plain are acid for the most part while those on the Piedmont are not.

Mr. George E. Sudworth discussed "The distribution of trees in the floral area." Oaks predominate and constitute from one half to three fourths of the upland cover. There are about 140 species of native and naturalized trees of which the broad-leaved trees number about 122 species.

"Humus as a factor in plant distribution" was discussed by Mr. Frederick V. Coville. Mr. Coville exhibited two samples of organic matter—the one a raw, brown and leafy turf found in laurel thickets produced chiefly by the decay of the laurel leaves, and the other a black, fully-reduced, non-structural leafmold formed by leaves high in lime content such as the tulip poplar. The former is acid and the latter alkaline in reaction.

Mr. P. L. Ricker discussed briefly the subject of "Collecting and preparing specimens." Mr. Ricker exhibited several types of portfolios suitable for collecting plants and also suggested the use of corrugated driers and artificial heat, especially where large numbers of plants are being collected on field trips.

The program was followed by an informal discussion by Messrs. Safford, Beattie, Norton, Waite, Lewton, Shantz, Coville, Hitchcock, Sudworth and Ricker.

H. L. Shantz,
Corresponding Secretary